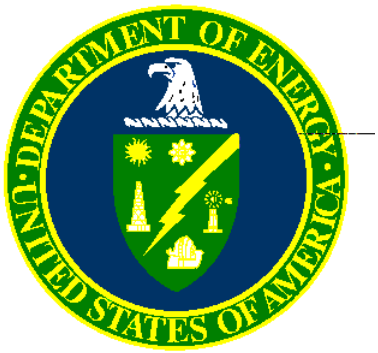


U.S. Department of Energy
Technical Qualifications Program

Nuclear Explosive Safety Topical Area

Training-to-Competency Curriculum Matrix
&
Training-to-Competency Matrix

Nevada Operations Office

October 1996

A. Introduction

1. Scope and Background

This curriculum matrix and training-to-competency matrix encompass those competencies addressing nuclear explosive safety (weapons) skills and knowledge which have been identified as part of the "common functional area competency requirements" in the Department of Energy (DOE) *Nuclear Explosive Safety Qualification Standard*, August 1995. The implementation of this Standard fulfills one of DOE's commitments to Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 93-3, *Improving DOE Technical Capability in Defense Nuclear Facilities Programs*. This curriculum matrix and training-to-competency matrix were developed in support of the Lead Site Concept by the Nevada Operations Office.

As referenced in DOE Order 360.1, Training, the acquisition of these nuclear fundamentals competencies can be demonstrated by three methods:

competency equivalency documented by previous training, education, and experience;
competency evaluation of knowledge and skills using examinations and performance evaluations usually following the completion of a course;
competency exemption which is a written release from the requirement to meet a specific competency.

Some general examples of these methods include:

- documentation of equivalent training or education
- a test-out (or challenge test)
- a requirement waiver
- completion of applicable course work
- taking a course of instruction
- demonstrating competency acquisition through job performance

2. Purpose

The purpose of the curriculum matrix is to provide a **suggested** roadmap of courses and developmental assignments that allow acquisition of appropriate nuclear explosive safety skills and knowledge.

The purpose of the training-to-competency matrix is provide a listing of courses that either fully or partially meet the stated competency.

3. How to Use the Curriculum Matrix

Each curriculum matrix depicts the suggested course or courses that help an individual acquire the skills and knowledge associated with a particular nuclear explosive safety (weapon) competency. **The curriculum matrix is not mandatory**, but provides a recommended sequence for course completion and identifies advanced courses that can be taken, if required, for an individual's current duty assignment. Additionally, the curriculum matrix suggests that individual developmental assignments be designed and administered by the owning organization, to ensure the qualification candidate fully meets the competency requirements. Attending courses does not ensure an individual is competent to perform a particular job. Controlled and supervised practice in the field is a necessity and highly recommended for the nuclear explosive safety area.

4. How to Use the Training-to-Competency Matrix

The training-to-competency matrix identifies courses that either fully or partially meet a particular competency. The matrix also identifies advanced courses that may be desirable for personnel requiring more extensive knowledge in a particular competency area. **The training-to-competency matrix is not mandatory**, but provides a quick reference to the available courses and what competency the course supports. For courses that partially meet or exceed competency requirements, it is incumbent on the supervisor to match the skills and/or knowledge associated with the competency to the course description/objectives to ensure unique job requirements for each employee are met.

5. Omission of a Nuclear Explosive Safety (Weapons) Self-Study Guide

No self-study material has been developed for the nuclear explosive safety (weapons) topical area for two main reasons. 1. The self-study material required to satisfy the competencies would be extremely voluminous and in most cases classified, making study extremely difficult. 2. Subject-matter experts, from around the complex, felt that a self-study guide would be both inappropriate and insufficient to meet the needs of personnel in the nuclear explosive safety area. However, in an effort to assist personnel to become familiar with the nuclear explosive safety area, primer-level texts are referenced in Section 6.

6. Available Primer-Level Texts

a. Title: ***An Introduction to Nuclear Weapons, Samuel Glasstone and Leslie M. Redman***

Sponsored By: U.S. Atomic Energy Commission

Report Number: WASH - 1037

Security Classification: Secret

Ordering Information: Contact your local technical library for ordering.

b. Title: ***Nuclear Explosive Training Manual***

Sponsored By: DOE Albuquerque Operations Office

Security Classification: Secret

Ordering Information: Contact DOE/AL Nuclear Explosive Safety Division (NESD) (505) 845-5902

c. Title: ***Caging the Dragon - The Containment of Underground Nuclear Explosions, James Carothers, Lawrence Livermore National Laboratory.***

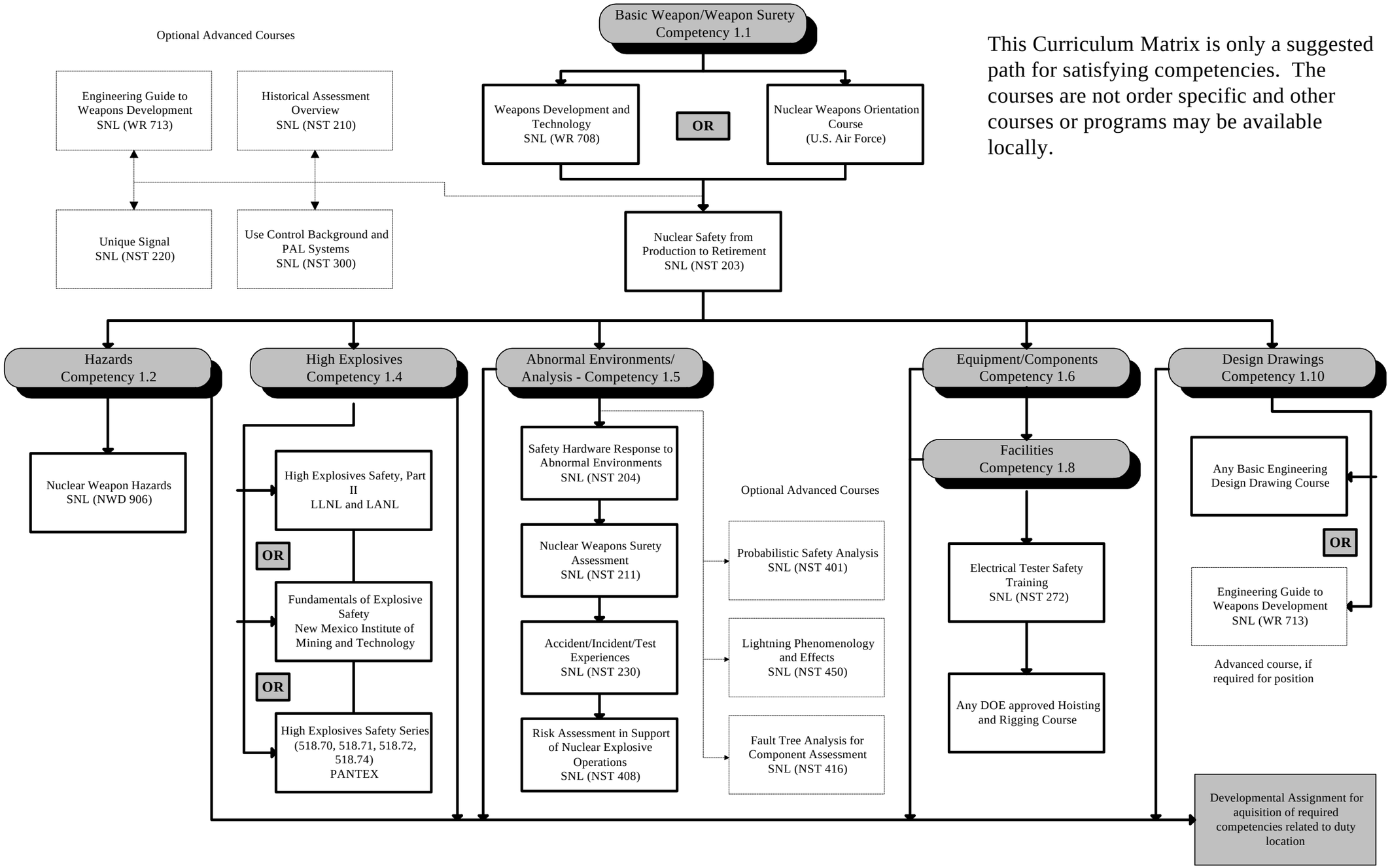
Sponsored By: DOE/Defense Programs
Defense Nuclear Agency

Report Number: DOE/NV-388
DNA-TR-95-74

Security Classification: Unclassified

Ordering Information: Contact the Office of Scientific and Technical Information, Oak Ridge, TN (615) 576-8401

B. Curriculum Matrix - General Technical Competencies



This Curriculum Matrix is only a suggested path for satisfying competencies. The courses are not order specific and other courses or programs may be available locally.

C. Competency-to-Training Matrix - General Technical Competencies

Activity	Nuclear Explosive Safety General Technical Competencies						
	1.1	**1.2**	**1.4**	**1.5**	**1.6**	**1.8**	**1.10**
Course: ***Accident/Incident/Test Experiences*** (SNL NST 230)				*			
Course: ***An Engineering Guide to Weapons Development, Production, and Stockpile*** (SNL 713)	*, A						X,A
Course: ***DOE Risk Assessment in Support of Nuclear Explosive Operations*** (SNL NSTE 408)				*			
Course: ***Electrical Tester Safety Training*** (SNL NST 272)					*	*	
Course: ***Fault Tree Analysis for Component Assessment*** (SNL NST 416)				*, A			
Course: ***Fundamentals of Explosive Safety*** (New Mexico Institute of Mining and Technology)			X				
Course: ***High Explosives*** (PANTEX 518.71)			*				
Course: ***High Explosives Safety - Part II Applications for Nuclear Weapons*** (LANL/LLNL)			X				
Course: ***Historical Assessment Overview*** (SNL NST 210)	*, A						
Course: ***Lightning Phenomenology and Effects*** (SNL NST 450)				*, A			

X Fully Meets the Competency
* Partially Meets the Competency
A Advanced Course - exceeds certain competency requirements, but does not necessarily cover all associated skills and knowledge

NOTE: For courses that partially meet or exceed the competency requirements, the supervisor should match the skills and/or knowledge associated with the competency to the course description/objectives to ensure unique job requirements for each employee are met.

Activity	Nuclear Explosive Safety General Technical Competencies						
	1.1	**1.2**	**1.4**	**1.5**	**1.6**	**1.8**	**1.10**
Course: ***Nuclear Safety From Production to Retirement: Background and Principles*** (SNL NST 203)	*						
Course: ***Nuclear Safety Hardware Response to Abnormal Environments and Historical Experiences*** (SNL NST 204)				*			
Course: ***Nuclear Weapons Hazards*** (SNL NWD 906)		X					
Course: ***Nuclear Weapons Orientation Course*** (USAF DNWS-R001)	*						
Course: ***Nuclear Weapons Surety Assessment*** (SNL NST 211)				*			
Course: ***Probabilistic Safety Analysis*** (SNL NST 401)				*, A			
Course: ***Propellants and Pyrotechnics*** (PANTEX 518.72)			*				
Course: ***Properties of Explosive Materials*** (PANTEX 518.70)			*				
Course: ***Storage of Explosives*** (PANTEX 518.74)			*				

X Fully Meets the Competency
* Partially Meets the Competency
A AdvancedCourse - exceeds certain competency requirements, but does not necessarily cover all associated skills and knowledge

NOTE: For courses that partially meet or exceed competency requirements, the supervisor should match the skills and/or knowledge associated with the competency to the course description/objectives to ensure unique job requirements for each employee are met.

Activity	Nuclear Explosive Safety General Technical Competencies						
	1.1	**1.2**	**1.4**	**1.5**	**1.6**	**1.8**	**1.10**
Course: ***Survey of Weapons Development and Technology*** (SNL WR 708)	*						
Course: ***Unique Signal*** (SNL NST 220)	*, A						
Course: ***Use Control and Background and PAL Systems*** (SNL NST 300)	*, A						

X Fully Meets the Competency
* Partially Meets the Competency
A Advanced Course - exceeds certain competency requirements, but does not necessarily cover all associated skills and knowledge

NOTE: For courses that partially meet or exceed competency requirements, the supervisor should match the skills and/or knowledge associated with the competency to the course description/objectives to ensure unique job requirements for each employee are met.

D. Nuclear Explosive Safety - General Technical Competencies

1. Competency 1.1

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the internal design of nuclear explosive/weapon systems, components and mechanisms.

Supporting Knowledge and/or Skills

a. Discuss the function, purpose, and design of the following systems and components:

- Arming
- Fusing
- Firing
- High explosives
- Fusionable material
- Fissile material - primary and secondary
- Detonators
- Boosting device
- Neutron generators (zippers)
- Ancillary hazardous systems

b. Describe the nuclear explosive/weapon command and control features with respect to the following:

- Personnel
- Electronics
- Mechanics/required signals - PAL (permissive action link)

c. Discuss the principles of nuclear weapon design specific to the following:

- Stockpile-to-Target Sequence
- Military Characteristics

d. State and discuss the nuclear weapon design safety criteria from DOE Order 5610.10, Nuclear Explosive and Weapon Surety Program including:

- Normal environment
- Abnormal environment
- One-point safety
- Dispersal safety

e. Discuss nuclear detonation safety design principles and describe nuclear explosive components/features that have been employed to provide isolation, inoperability, and incompatibility, including:

- Barriers
- Weak links
- Strong links
- Unique signals

f. Discuss the role of independence and first principles in the implementation of the nuclear detonation safety design principles (safety theme).

g. Describe nuclear explosive design features that have been employed to prevent/mitigate fissile material dispersal including:

- Insensitive high explosives
- Fire-resistant pits

2. Competency 1.2

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the radiological, equipment, and personnel hazards associated with nuclear explosives/weapons.

Supporting Knowledge and/or Skills

a. Discuss the radiological characteristics, and related hazards to personnel and equipment from the following materials used in nuclear explosives/weapons:

- Uranium
- Plutonium
- Tritium

b. Discuss the general quantity and configuration of the materials used in nuclear explosives/weapons that present a potential radiological hazard to personnel and equipment.

c. Describe how as-low-as-reasonably-achievable (ALARA) considerations are incorporated into the procedures for the handling and storage of nuclear explosives/weapons.

d. Identify the hazards to personnel and equipment from each of the following features of nuclear explosive/weapon design:

- Spin rockets
- Retarding devices
- Pre-flight controllers
- Boosting device

e. Describe toxic materials typically found in nuclear explosives and weapons, the hazards associated with them, and the safety precautions that should be taken.

f. Describe the physical effects of a high explosive detonation and a nuclear detonation in terms of:

- Blast
- Radiation
- Thermal

3. Competency 1.4

Nuclear explosive safety personnel shall demonstrate a working level knowledge of high explosives and their applicability in nuclear explosives/weapons.

Supporting Knowledge and/or Skills

a. Define the following terms:

- Conventional high explosives (CHE)
- Insensitive high explosive (IHE)
- One point detonation

b. Discuss the difference between insensitive high explosives (IHE) and conventional high explosives (CHE) used in nuclear explosives/weapons.

c. Describe the function of primary and secondary explosives in nuclear explosive/weapon design.

d. Define and compare the effects of the following interrelated high explosive terms that apply to nuclear explosive/weapon design:

- Detonations
- Violent reactions
- Deflagration
- Combustion

e. Describe the response of high explosives used in nuclear explosive/weapon design to the following external stimuli:

- Mechanical
- Electrical
- Thermal

f. Discuss the effects of aging on the high explosive materials used in nuclear explosive/weapon design.

g. Discuss the toxic properties of the high explosive materials used in nuclear explosive/weapon design.

4. Competency 1.5

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the effects of abnormal environments on nuclear explosives/weapons.

Supporting Knowledge and/or Skills

a. Define the term "abnormal environment."

b. List the categories of abnormal environments specific to nuclear explosive/weapon operations and storage, and describe the characteristics of each.

c. Given a set of conditions that make up an abnormal environment for a nuclear explosive/weapon, assess and evaluate a single abnormal environment including the credibility of multiple abnormal environments. Include the following in the evaluation:

- Identifying hazards
- Identifying the effects on the nuclear explosive
- Identifying mitigating measures to be taken

5. Competency 1.6

Nuclear explosive safety personnel shall demonstrate a working level knowledge of tooling, testers, rigging, and hoisting equipment used for handling nuclear explosives/weapons.

Supporting Knowledge and/or Skills

a. Explain how the design of each of the following is important in minimizing or eliminating the potential for mishandling nuclear explosives/weapons and preventing accidents.

- Tooling
- Testers
- Rigging equipment
- Hoisting equipment

b. Read and interpret design drawings and technical specifications for the tooling, testers, rigging, and hoisting equipment used in handling nuclear explosives/weapons.

c. Explain the importance of proper certification of slings and hoisting equipment used in handling nuclear explosives/weapons.

d. Explain the importance of proper certification of testers used in nuclear explosives/weapons operations.

6. Competency 1.8

Nuclear explosive safety personnel shall demonstrate a working level knowledge of facility system interfaces and their potential effects on nuclear explosives.

Supporting Knowledge and/or Skills

a. Identify the potential hazards that pneumatic and hydraulic systems present to the safety of nuclear explosive operations and associated activities.

b. State the purpose and significant features of heating, ventilation, and air-conditioning systems that service nuclear explosive areas and discuss the effects of these systems in normal and abnormal environments.

c. Describe the hazards presented to the safety of nuclear explosive operations and associated activities by the introduction of alternating current (AC) and direct current (DC) electrical energy sources, or equipment using any electrical source, into a nuclear explosive area.

d. Describe the controls and design measures to prevent or limit the introduction of electrical energy into a nuclear explosive area.

7. Competency 1.10

Nuclear explosive safety personnel shall demonstrate the ability to interpret nuclear explosive design drawings and electrical schematics.

Supporting Knowledge and/or Skills

a. Identify the symbols and/or codes used on design drawings and specifications to depict the relationship between components.

b. State the condition in which all electrical devices are shown, unless otherwise noted on the diagram or schematic.

c. Given a simple electrical schematic and initial conditions, identify the power sources and/or loads and their status.

E. General Technical Competencies - Supporting Courses and Descriptions

1. Accident/Incident/Test Experiences (SNL NST 230)

This half-day course details selected accidents, incidents, and test experiences (including Palomares, Thule, and Damascus). The intent is to show by example some of the unexpected phenomena that safety analysts must learn to foresee, and to give a sense of how likely it is that something unlikely will happen.

How to Register:

Contact the Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721.

2. An Engineering Guide to Nuclear Weapons Development, Production, and Stockpile (SNL WR 713)

This series of ten morning classes emphasize Sandia's role in the activities, procedures, and methods used to acquire and maintain a reliable stockpile of nuclear weapons. Major milestones in the seven weapon phases will be covered, including weapon project management, drawing and specification alternatives, documentation requirements, and resource management. Emphasis will be placed on activities that occur at SNL from both the system and component engineering perspectives. Weapon hardware and cutaways will be used as illustrations. The component sections will provide a basic understanding of weapon component design and operation including principles of operation, applications, manufacturing processes, design considerations, component limitations, availability, reliability, and method qualification. Guest speakers from other installations will explain their group's functions and how they interact with Sandia. One session will be a tour of the Nuclear Weapons School Museum.

Prerequisites:

A Q-Clearance with access to weapons data ("W" badge).

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-3247.

3. DOE Risk Assessment in Support of Nuclear Explosive Operations (SNL NSTE 408)

This three and one half-day course is designed to support the Nuclear Explosive and Weapon Safety (NEWS) program, and is required for Nuclear Explosive Safety Study Group (NESSG) members.

The purpose of this course is to provide the student with an introduction to system analysis techniques called risk assessments, provide instruction on hazard assessments for nuclear weapons, provide instruction on the use of event trees as an inductive system analysis tool for developing accident scenarios, and provide instruction on how a fault tree is used in assessing nuclear detonation pathways for a nuclear weapon system.

How to Register:

To express interest in the above course, call Jessie Brooks at the DOE Albuquerque Operations Office at (505) 845-5156 (Voice) or (505) 845-4309 (Fax). You will be notified when a course date has been scheduled.

4. Electrical Tester Safety Training (SNL NST 272)

This one-day course is designed to support the Nuclear Explosive and Weapon Safety (NEWS) program, and is required for Nuclear Explosive Safety Study Group (NESSG) members.

This course will give the student an understanding of the risks and safety of electrical tests, the design and construction of testers, the use of testers at PANTEX and related documents. Topics include:

Understanding Hazards of Voltage and Current
Comparison of Electricity and Fluids
Faults and Combination of Faults
Nuclear Explosive Safety
Possible Consequences of Unintended Currents
Design Principles and Considerations
Voltage Limiters
Electro-Static Discharge (ESD)

How to Register:

Contact the Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721.

5. Fault Tree Analysis for System Assessment (SNL NST 416)

This one-half day course examines the principles of performing weapon system fault tree safety assessment. The logic of fault tree construction, some examples of assessment, and the use of fault tree software will be included. Limitations of fault trees will also be addressed.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

6. Fundamentals of Explosive Safety (New Mexico Institute of Mining and Technology)

This five-day course is designed to acquaint students with techniques and safety requirements, and to introduce safe operating procedures to be used at firing sites and laboratories where research using energetic materials is conducted. Topics include:

Fundamentals of Safety
Properties of Explosives-Shockwaves and Explosive Materials
Walk-through Detonation Velocity Tests and Discussion of Detonators, Boosters, etc.
Safety in the Development of Explosives
Gas Evolution, Henkin, Cook-off, and DSC Tests
Drop Weight Sensitivity Testing
Friction and Electrostatic Discharge Sensitivity Testing
Walk-through the Gas Evolution, Henkin, Friction, ESD, and Drop Weight Impact Tests
Instrumentation Techniques-Pins
Instrumentation Techniques-Timing
Instrumentation Techniques-Optical
Instrumentation Hazards-X-ray, Spark, etc.
Hands-on Making of Instrumentation
Introduction to Safety Manuals and Safe Operating Procedures (SOPS)
Philosophy of SOPs
Contents of SOPS; Writing an SOP
Range Clearance and Fragment Zones
Walk-through Range Clearance and Safety; Walk-through Shot Using Written SOP
Laboratory Hazards
Transportation, Handling, and Storage of Ammunition and Explosives
Processing of Melt-Cast and Polymer-Bonded Energetic Materials
Walk-through Procedures for Weighing, Mixing, and Preparation of Melt Explosive

How to Register:

Contact the New Mexico Institute of Mining and Technology, Energetic Materials Research and Testing Center, (505) 835-5774.

7. High Explosives (PANTEX 518.71)

This two-hour course gives definitions of primary, secondary, and insensitive high explosives, and discuss different chemical compounds and their characteristics, manufacturing, and uses. The student will examine how the different explosive materials are used and the importance of insensitive high explosives in the weapons program.

Objectives:

Identify the three primary types of explosives used at PANTEX.
Define a primary explosive.
Identify primary explosives and their respective characteristics.
Identify methods to detonate primary explosives.
Define a secondary explosive.
Identify secondary explosives and their respective characteristics.
Define a composition explosive.
Identify composition explosives and their respective characteristics.
Identify the main components/properties of IHE.
Analyze the testing process for IHE.

Prerequisites:

Properties of Explosive Materials (PANTEX 518.70)

How to Register:

Contact the Amarillo Area Office Training Manager at (806) 477-6188.

8. High Explosive Safety - Part II Applications for Nuclear Weapons (LANL/LLNL)

This two-day course covers the following topics:

Types of High Explosives in Nuclear Weapons
High Explosive Development Process

Small Scale Safety Tests and Results (materials)
Drop Weight Impact
Thermal

Large Scale Safety Tests and Results (components)
Impact Tests
Thermal Tests
Thermal Modeling
Detonator/Booster
Bullet Testing

Full Scale Weapons Tests and Results
LANL Impact Tests
LANL Impact Modeling
LLNL Impact Tests
LLNL Impact Modeling
LANL Thermal Test Results
LLNL Thermal Test Results
Aging Effects on High Explosive Safety Properties
Risk Assessment Applications NESS
Test Movies - Discussion - Review

How to Register:

Contact James Humphrey, LLNL (510) 423-1844 or Larry Hatler, LANL (505) 667-6738 to register.

9. Historical Assessment Overview (SNL NST 210)

This one-half day course looks at the first approaches to surety assessment, including the evolution of the DoD and DOE Standards and Military Characteristics for Nuclear Weapon Safety. Early study techniques are outlined including the Technical Working Group (TWG) Studies of the Mid 1970's. More recent studies/assessments are also discussed, including the Soft Spot Analyses of the 1980's, WAP and NSAFE. Also discussed are the incidents of concern and the changes in approach.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

10. Lightning Phenomenology and Effects (SNL NST 450)

This one-half day course will provide information on the following: characteristics and frequency of occurrence of lightning, the interaction of lightning with nuclear weapons and nuclear weapon systems, and engineered protection against direct strike and nearby lightning.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

11. Nuclear Safety from Production to Retirement: Background and Principles (SNL NST 203)

This half-day course summarizes the reasons for extraordinary care in the design, production, and use of abnormal-environment-resistant safety features in nuclear weapons. Nuclear safety principles and their implementation are shown, including the background for Enhanced Nuclear Detonation Safety (ENDS), the concepts of active and passive safety, traceable safety subsystems and a brief introduction to identification of Pentagon S features.

How to Register

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

12. Nuclear Safety Hardware Response to Abnormal Environments and Historical Experiences (Burned Board Room) (SNL NST 204)

This half-day course utilizes laboratory/exhibit demonstrations with the aim of explaining the reasons for extraordinary safety care, the role of abnormal environments, abnormal-environment safety features, and the background for Enhanced Nuclear Detonation Safety (ENDS).

Prerequisites:

A SECRET/RD security clearance is required for entry into the Burned Board Room.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

13. Nuclear Weapon Hazards (SNL NWD 906)

This one hour course addresses nuclear hazards in the "normal" (aimed at maintenance personnel) and "abnormal" (aimed at Explosive Ordnance Disposal personnel) environments. The “normal environment" discussion addresses such topics as intrinsic radiation, electro explosive devices, parachutes and spin-rocket motors, while the "abnormal environment" discussion discusses the hazards of the nuclear components, special nuclear material to include criticality and inadvertent pit boosting, and high explosives. Also addressed are the generic hazards of weapon electrical system components, like thermal batteries and explosive squibs.

Prerequisites:

Military: SECRET/RD/CNWDI clearance
DOE: Q clearance for SECRET/RD, Sigmas I and 2 access

How to Register:

Contact the Sandia National Laboratories Military Liaison Office (505) 844-1172.

14. Nuclear Weapons Orientation Course (USAF DNWS-R001)

This four-day course provides an overview of the U.S. Nuclear Weapons Program including the history and development of nuclear weapons, management of our nuclear stockpile, and issues and challenges now facing this program. Course curriculum includes twenty classes organized into the functional areas of Nuclear Weapons Fundamentals, Nuclear Weapons Effects, Nuclear Weapons Stockpile, and Nuclear Weapons Issues. The course focuses on the Weapons Display Area where students are instructed on every nuclear weapon system ever stockpiled by the United States. The themes of Safety, Security, Operational Effectiveness, and Counterproliferation are developed throughout the course.

Course Objectives:

Evaluate the scope of the national nuclear weapons program.
Describe basic nuclear physics and materials.
Identify the key elements of nuclear surety.
Describe the operational and physical characteristics of nuclear weapons.
Evaluate future development, testing, command and control, and weapons effects on stockpiled nuclear weapons.
Describe intelligence estimates and international agreements.
Discuss current nuclear weapons issues.

Prerequisites:

Secret/Restricted Data security clearance. Certified access to Critical Nuclear Weapons Design Information (CNWDI) is highly recommended, but not required, for the Weapons Display Area tour.

How to Register:

DOE employees should call (202) 426-1534 to register.

Mobile Training Teams

A mobile training team version of this course is available. Have your training office contact the DNWS Registrar for information on how to have a mobile training team visit your agency.

DNWS Registrar
FCDNA/FCINTR
1900 Wyoming Blvd SE
Kirtland AFB NM 87117-5669 or call (505) 846-5666 or DSN 246-5666.

15. Nuclear Weapons Surety Assessment (SNL NST 211)

This two part (one-half day each) course is designed to brief system surety assessors on principles and techniques of the assessment process.

Part one of the course explains the scope and purpose of nuclear weapon surety assessment, describes the objectives and process, and explains how to identify technically feasible threat conditions and safety needs at each stage of weaponization. Examples are given to illustrate a productive approach and to illustrate common problems.

Part two is a workshop that allows the student to apply the concepts from part one through participation in parts of a mock surety assessment.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

16. Probabilistic Safety Analysis (SNL NST 401)

Basic Probabilistic Risk Assessment (PRA) analysis techniques are introduced during this two-day course. Application to system assessment through fault trees and event trees is summarized. The use of analysis results and perception of risk are considered as factors. Abnormal and other extreme environments are addressed, and the need for special approaches to account for these environments is discussed. The advantages of applying analysis proactively rather than retroactively is discussed. Emphasis is placed on common conceptual, perceptual, and analytic traps and misconceptions, and several examples of sophisticated subtle traps are shown in order to raise caution about unexpected effects.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

17. Propellants and Pyrotechnics (PANTEX 518.72)

This two-hour course covers both propellants and pyrotechnics, and examines single-base, double-base, triple-base and composite propellants. The student will discuss the different pyrotechnics and the effects that can be produced. The student will also look at sound, light, heat, smoke, delay, and gas producers and where these items may be used in a weapons system.

Objectives:

Identify the different testing methods for sensitivity used in conventional explosives.
Identify some of the problems that can effect the results of your sensitivity test.
Identify the types of thermal tests.
Describe the different thermal test processes.
Identify the different tests used in sensitivity tests.
Identify the purpose for conducting an electrostatic sensitivity test.
Describe the process for conducting an electrostatic sensitivity test.
Explain the purpose of friction testing.
Describe the process for conducting friction testing.
Identify different machining safety tests.
Analyze the processes/results of machine tests.
Identify the purpose of a rifle bullet test.
Describe the process of conducting a rifle bullet test.
Explain the purpose for a skid test.
Describe the skid test process.
Identify the purpose for performance testing.
Analyze the process/results of performance testing.

Prerequisites:

Properties of Explosive Materials (PANTEX 518.70)

How to Register:

Contact the Amarillo Area Office Training Manager at (806) 477-6188.

18. Properties of Explosive Materials (PANTEX 518.70)

This four-hour course reviews the chemical reactions of different high-energy chemicals, synthesis and formulation, and energy release from high energy reactions. It also looks at the manufacturing processes and the importance of oxygen balance in the reaction.

Objectives:

Discuss the various explosive, physical, and chemical properties of explosive material and their manufacturing processes with minimal references.
Recognize the four chemical decompositions in a conventional explosion.
Analyze the different bonds/reactions in an explosive reaction.
Recognize the four chemical decompositions in a conventional explosion.
Characterize the thermodynamics of an explosive.
Identify the desired purpose/function of an explosive.
Describe what is needed to start a chemical reaction.
Identify conventional explosives formulation.
Describe what an oxidizer is and its preferred qualities.
Give examples of oxidizers and their characteristics.
Provide the three types of fuels.
Discuss the general characteristic of each fuel type.
Give examples, and their characteristics, of organic fuels.
Provide the main products from organic fuels.
Furnish examples, and their characteristics, of metal fuels.
Give examples, and their characteristics, of non-metallic fuels.
Describe what a binder is and its purpose.
Analyze the impact of homogeneity on explosive mixtures.
Analyze the reasons for energy release in a chemical reaction.
Identify the four manufacturing processes.
Identify the key manufacturing concerns.
Describe different methods for control to reduce accidents.
State the purpose of the Oxygen Balance in conventional explosives.

Prerequisites:

Basic Chemistry

How to Register:

Contact the Amarillo Area Office Training Manager at (806) 477-6188.

19. Storage of Explosives (PANTEX 518.74)

This two-hour course reviews the explosive hazard classifications and their individual associated hazards. The student will look at how to segregate the different explosive classifications and the problems associated with storing different classes together.

Objectives:

Describe the six different hazard divisions.
Identify the most hazardous division from the least.
Describe the classification process.
Identify the three main classification tests.
Analyze the role of packaging.
Describe the purpose of the different compatibility groups.
Identify the different compatibility groups.

Prerequisites:

Properties of Explosive Materials (PANTEX 518.70)

How to Register:

Contact the Amarillo Area Office Training Manager at (806) 477-6188.

20. Survey of Weapons Development and Technology (SNL WR 708)

This five-day course is designed to give a broad technical perspective of the nuclear weapons program. The topics covered include factors within and outside of the weapons complex that affect the weapons program. The following topics are covered:

Nuclear Effects	Tour of the Nuclear Weapons Museum
High Explosives, Detonators	Arming, Firing, and Initiation
Physics, Explosion Theory	Transfer Systems
Fission	Access Control/Use Control
Thermonuclear	Nuclear Testing
Safety	Arms Control
Fuzing	Stockpile Matters

Emphasis is on both technology (what and how) and philosophy (why).

Course Objectives:

Describe the principles of how nuclear weapons function from the nuclear physics perspective.
Describe the principles of nuclear weapons from the engineering implementation perspective.
Recognize some of the systems that are part of the nuclear weapons program.
Discuss the principles of nuclear surety (nuclear safety, use control, and security) and how it is implemented in the enduring stockpile
Discuss how weapons in the enduring stockpile operate and the interrelationship of the weapons.
Discuss the evolution of nuclear weapons over the past 50 years.
Describe the principle drivers of the nuclear stockpile over the last 50 years, i.e., what military requirements have had the greatest impact on the DOE and its predecessors.
Discuss nuclear weapons subsystem components and their evolution.

Prerequisites:

Q-Clearance with Atomic Weapon Data, Sigma 1 Access.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 845-9843.

21. Unique Signal (SNL NST 220)

This one-half day course details on the unique signal concept including background on why the approach was chosen from among other approaches (such as pattern recognition), the principles on which the approach is based and what the use of principles accomplishes, the design details of unique signal sequence patterns, and the payoffs to safety analysts, weapon system developers, and those responsible for the delivery system.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

22. Use Control Background and PAL Systems (SNL NST 300)

This course comprises two consecutive half-day sessions (mornings) that includes an introduction to Use Control with concentration on Permissive Action Link (PAL) systems. The course includes presentations on the definition and history of Use Control, the release system, and current and planned PAL systems and associated control equipment (code processors, recoders, decoders, coded switches, and other controllers). The course covers the basics of PAL code management as well as key management for encrypted systems. Also highlighted are the PAL requirements process, National Security Agency (NSA) materials, encryption concepts, and an overview and rationale for Use Control systems in development. Specific design details and operational parameters of Use Control systems, particularly Sensitive Use Control Information (SUCI), are not discussed.

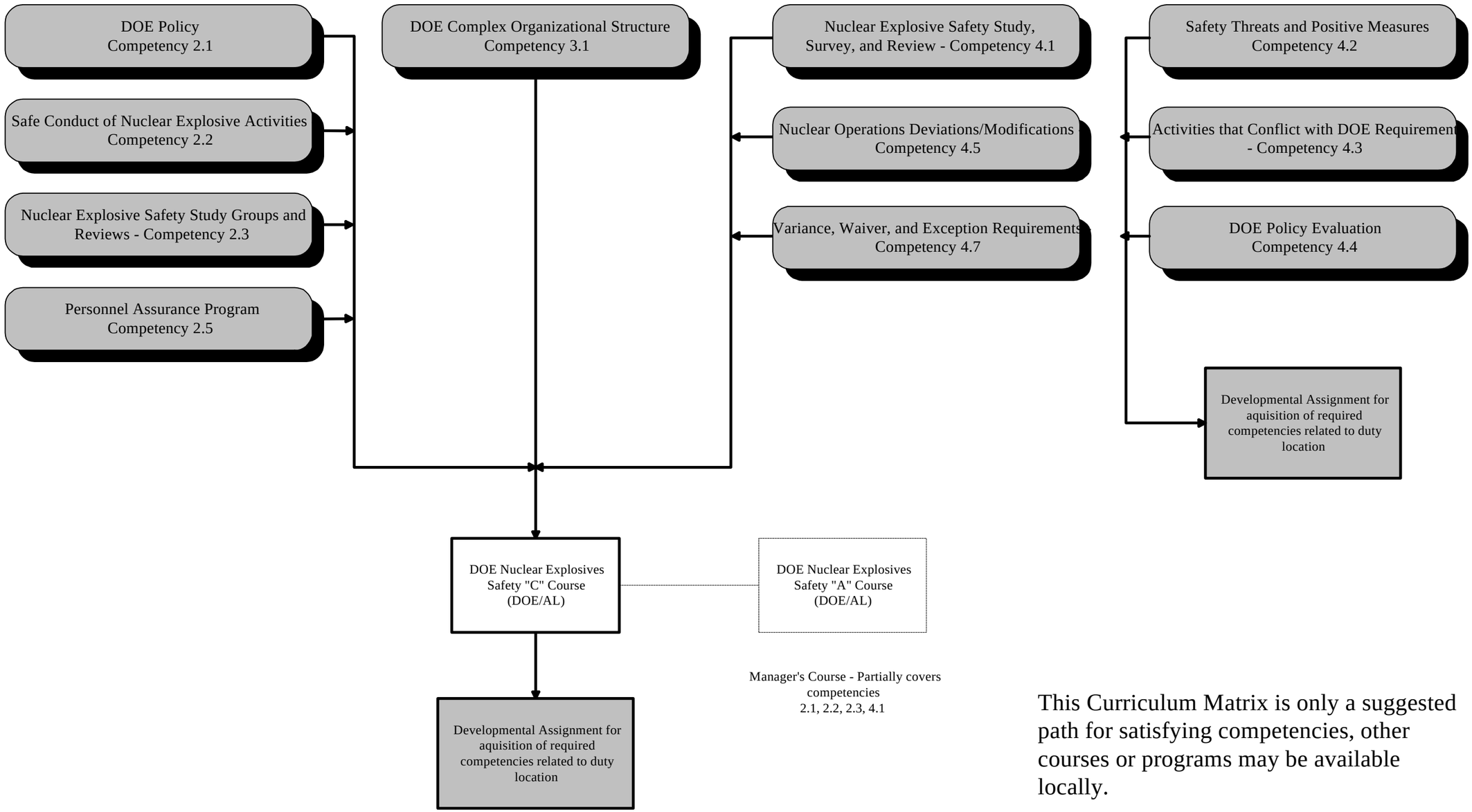
Prerequisites:

Course is classified up to Secret-Restricted-Data. The student's need-to-know will be established by course instructors in conjunction with the respective manager using the NST enrollment form.

How to Register:

Contact the Sandia National Laboratories Education and Training Department at (505) 844-4721.

F. Curriculum Matrix - Regulatory, Administrative, and Management, Assessment, and Oversight Competencies



This Curriculum Matrix is only a suggested path for satisfying competencies, other courses or programs may be available locally.

G. Training-to-Competency Matrix - Regulatory, Administrative, and Management, Assessment, and Oversight Competencies

Activity	Nuclear Explosive Safety Regulatory, Administrative, and Management, Assessment, and Oversight Competencies										
	2.1	**2.2**	**2.3**	**2.5**	**3.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.7**
Course: ***DOE Nuclear Explosive Safety Training "A"*** (DOE/AL NTSE 270-A) (505) 844-4721	*	*	*			*					
Course: ***DOE Nuclear Explosive Safety Training "C"*** (DOE/AL NTSE 270-C) (505) 844-4721	X	X	X	X	X	X				X	X

X Fully Meets the Competency
* Partially Meets the Competency

NOTE: For courses that partially meet or exceed competency requirements, the supervisor should match the skills and/or knowledge associated with the competency to the course description/objectives to ensure unique job requirements for each employee are met.

H. Nuclear Explosive Safety - Regulatory, Administrative, and Management, Assessment, and Oversight Competencies

1. Competency 2.1

Nuclear explosive safety personnel shall demonstrate an expert level knowledge of the Department of Energy (DOE) policy, objectives, standards and criteria, authorities, and responsibilities as described in DOE Order 5610.10, Nuclear Explosive and Weapon Surety Program.

Supporting Knowledge and/or Skills

a. Discuss the purpose, scope and applicability of DOE Order 5610.10, Nuclear Explosive and Weapon Surety Program.

b. Define the following terms that are used in DOE Order 5610.10, Nuclear Explosive and Weapon Surety Program:

- Abnormal environment
- Environment, Safety, and Health (ES&H)
- Normal environment
- Nuclear explosive
- Nuclear weapon
- Nuclear explosive operation
- Nuclear explosive operation associated activities
- Nuclear Explosive Safety (NES)
- Positive measures

c. Discuss the Nuclear Explosive and Weapons Surety Program policy and objectives and describe its basic elements.

d. Explain the line management responsibilities within the Nuclear Explosive and Weapons Surety Program.

e. Discuss the nuclear explosive surety standards established in DOE Order 5610.10, Nuclear Explosive and Weapons Surety, and their application to nuclear explosive operations.

2. Competency 2.2

Nuclear explosive safety personnel shall demonstrate an expert level knowledge of the policy, procedures, authorities, and responsibilities established to ensure safe conduct of nuclear explosive activities as described in DOE Order 5610.11, Safety of Nuclear Explosive Operations

Supporting Knowledge and/or Skills

a. Discuss the policy, objectives, and applicability of DOE Order 5610.11, Safety of Nuclear Explosive Operation.

b. Define the following terms used in DOE Order 5610.11, Safety of Nuclear Explosive Operation:

- Access
- Custody
- Fissile Material Contamination
- Fissile Material Dispersal
- High explosive deflagration
- High explosive detonation
- Nuclear detonation
- Nuclear explosive area
- Nuclear explosive duty
- One-point-safe nuclear explosive

c. Discuss the program requirements for initial training and qualifying of Department of Energy and DOE contractor personnel for assignment to nuclear explosive duties as described in DOE Order 5610.11, Safety of Nuclear Explosive Operations.

d. Explain the two-person concept for operations involving nuclear explosives.

e. Discuss the nuclear explosive safety standards in DOE Order 5610.11, Safety of Nuclear Explosive Operations, to prevent unintended nuclear detonation or fissile material dispersal.

f. Discuss the general nuclear explosive safety rules established in DOE Order 5610.11, Safety of Nuclear Explosive Operations, for all Department nuclear explosive operations.

g. Explain why the following are needed to ensure the safe conduct of nuclear explosive operations and associated activities:

- Nuclear Explosive-Like Assembly (NELA) requirements
- Permanent Marking Instructions
- Control of Electrical Testers/Equipment

3. Competency 2.3

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the Nuclear Explosive Safety Study Group (NESSG), and the Nuclear Explosive Safety Study (NES Study), Nuclear Explosive Safety Survey (NES Survey), and Nuclear Explosive Safety Review (NES Review) processes described in the following Department of Energy (DOE) directives:

- **DOE Order 5610.11, Safety of Nuclear Explosive Operations**
- **DOE-STD-YYYY-95, Nuclear Explosive Safety Study Process (when issued)**

Supporting Knowledge and/or Skills

a. Describe the organization requirements for a Nuclear Explosive Safety Study Group (NESSG).

b. Describe the scope of the Nuclear Explosive Safety Study Group (NESSG) responsibilities.

c. Explain the functions of a NES Study, a NES Survey, and a NES Review.

d. Discuss DOE Order 5610.11, Safety of Nuclear Explosive Operations requirements for conducting a NES Study and NES Survey.

e. Explain how changes in each of the following types of planned operations could require a new NES Study and NES Survey:

- Dismantlement schedule
- Nuclear testing schedule
- Testing schedule
- New build and rebuild schedule
- Transportation schedule
- Revised programmatic/safety priorities
- Weapon custody

f. Describe the approval level requirements for a NES Study, a NES Survey, and a NES Review.

g. Explain the relationship between a Master Study and a specific study.

4. Competency 2.5

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the Personnel Assurance Program described in the following Department of Energy (DOE) directives:

- **DOE Order 5610.11, Safety of Nuclear Explosive Operations**
- **DOE-STD-ZZZZ-95, Personnel Assurance Program (when issued)**

Supporting Knowledge and/or Skills

a. Discuss the purpose of the Personnel Assurance Program.

b. Discuss the responsibilities of management and supervisory personnel under the Personnel Assurance Program.

c. Discuss the Personnel Assurance Program certification requirements.

d. Describe the purpose for the immediate, temporary removal from nuclear explosive duties of an individual whose suitability for performing such duties is in question.

e. Explain the purpose of a Personnel Assurance Program certification list.

5. Competency 3.1

Nuclear explosive safety personnel shall demonstrate a working level knowledge of the Department of Energy (DOE) organizational structure, its technical laboratories, relevant Department of Defense interfaces, and DOE contractor responsibilities.

Supporting Knowledge and/or Skills

a. Discuss the responsibilities and authorities for nuclear explosive safety of the following positions within the Department of Energy:

- Secretary of Energy (S-1)
- Assistant Secretary for Defense Programs (DP-1)
- Assistant Secretary for Environment, Safety, and Health (EH-1)
- Deputy Assistant Secretary for Military Application and Stockpile Support (DP-20)
- Office of Security Affairs (NN-50)
- Director of Security Evaluation (EH-4)
- Managers of Operations Offices

b. Discuss the lines of authority between the Department of Energy and its technical laboratories involved with nuclear explosive safety.

c. Describe the Department of Defense and Department of Energy interfaces relative to nuclear weapon safety.

d. Describe the relationship between the Department of Energy and its contractors regarding responsibility for nuclear explosive safety.

6. Competency 4.1

Nuclear explosive safety personnel shall demonstrate the ability to plan, prepare, and perform a Nuclear Explosive Safety (NES) Study, a Nuclear Explosive Safety (NES) Survey, and a Nuclear Explosive Safety (NES) Review.

Supporting Knowledge and/or Skills

a. Given a set of conditions from which the need to perform a NES Study, a NES Survey, or a NES Review has been determined:

- Identify the scope of nuclear explosive safety operations, facilities, and equipment to be studied or surveyed.
- Describe the study group membership.
- Communicate Department of Energy (DOE) expectations of the conduct of the Nuclear Explosive Safety Study to all those who will participate in the study.
- Identify any potential concerns pertinent to the device being studied.
- Prepare a comprehensive draft report for the study.

b. During the planning and performance of a NES Study, a NES Survey, or a NES Review, coordinate the participation of contractors in the compilation, analysis, and evaluation of data.

c. During the planning and performance of a NES Study, a NES Survey, or a NES Review, evaluate the need for special briefings to provide supplemental information to study participants.

7. Competency 4.2

Nuclear explosive safety personnel shall demonstrate the ability to identify potential threats to nuclear explosive safety, and evaluate the adequacy of positive measures to assure nuclear explosive safety.

Supporting Knowledge and/or Skills

a. Evaluate nuclear explosive operations and all applicable technical data.

b. Evaluate nuclear detonation safety design and configuration during nuclear explosive operations including:

- Isolation:

    1. Identify when barriers are breached during assembly/disassembly
    2. Identify when strong links are absent or potentially bypassed.

- Incompatibility:

    1. Identify available energy sources and their effects on nuclear explosive components
    2. Identify available signals, such as in testers, that could drive a unique signal discriminator

- Inoperability:

    1. Identify defined weak links in various nuclear explosives
    2. Describe the features and safety role of the weak link(s)

c. Evaluate potential nuclear criticality risks associated with an operation or test to be performed.

d. Evaluate the description and analysis of the design safety features of a nuclear explosive.

e. Evaluate electrical tester designs, safety analyses, and tester/nuclear explosive interfaces.

f. Evaluate special tooling and written procedures used for nuclear explosive operations.

g. Evaluate facilities and associated equipment used for nuclear explosive operations.

h. Evaluate the adequacy of a Safety Analysis Report (SAR), a Hazard Analysis Report (HAR), and a Nuclear Explosive Safety Study (NES Study) input document (including Nuclear Explosive Hazards Assessment) and evaluate the associated:

- Hazard analyses
- Accident analyses
- Identification of safety-class and safety-significant Structures, Systems, Components
- Derivation of Technical Safety Requirements, Operational Safety Controls, and Nuclear Explosive

i. Evaluate the safety analyses of nuclear explosive pre-arming, arming, timing, and firing systems and procedures.

j. Analyze descriptions of countdowns, emergency stops and hold capabilities.

k. Analyze security operations for potential threats to a nuclear explosive.

l. Evaluate the on-site and off-site transportation of nuclear explosives.

m. Evaluate analyses of nuclear detonation responses of nuclear explosives to an abnormal environment.

8. Competency 4.3

Nuclear explosive safety personnel shall demonstrate the ability to identify conflicting requirements between other regulatory documents and nuclear explosive safety.

Supporting Knowledge and/or Skills

a. Given a set of conditions for a nuclear explosive operation, identify activities that pose potential hazards or conflicts with DOE Order 5610.11, Safety of Nuclear Explosive Operations.

b. Given a set of conditions for a nuclear explosive operation where a potential hazard or conflict has been identified, develop and implement recommendations and/or guidelines to mitigate the identified hazards or conflicts.

9. Competency 4.4

Nuclear explosive safety personnel shall demonstrate the ability to review nuclear explosive safety Orders, policies, guidelines, and directives.

Supporting Knowledge and/or Skills

a. Given a proposed Order, policy, guideline, or directive, evaluate the document for adequacy, impact on the safety of nuclear explosive operations, and consistency with other policies, guidelines, and procedures.

10. Competency 4.5

Nuclear explosive safety personnel shall demonstrate the ability to process requests for administrative approval of deviations/modifications to a nuclear explosive operation.

Supporting Knowledge and/or Skills

a. Review requests for deviations to a nuclear explosive operation.

b. Document positions for administrative approval of requests for deviations to a nuclear explosive operation.

11. Competency 4.7

Nuclear explosive safety personnel shall demonstrate a working level knowledge of variance, waiver, and exception requirements specified in DOE Order 5610.11, Safety of Nuclear Explosive Operations.

Supporting Knowledge and/or Skills

a. Define the following terms and describe the approval requirements for each:

- Variance
- Waiver
- Exception

b. Describe the specific elements of information to be included with each request for a variance, waiver, or exception.

c. Describe the use of alternate or equivalent means to meet a specific requirement of DOE Order 5610.11, Safety of Nuclear Explosive Operations.

d. Using an actual or hypothetical request for a variance, waiver, or exception, evaluate the request for adequacy, completeness, and compliance with DOE Order 5610.11, Safety of Nuclear Explosive Operations.

I. Regulatory, Administrative, and Management, Assessment, and Oversight Competencies - Supporting Courses and Descriptions

1. DOE Nuclear Explosive Safety Executive Orientation (SNL NSTE 270-A)

This one-half day course is intended to familiarize management level personnel with the fundamentals of the DOE nuclear explosive safety program. The course provides an overview of terms and standards, and program requirements (DOE Orders). It includes such topics as joint DOE/DoD Weapon System Safety, principles of nuclear explosive safety, principles of high explosive safety, stockpile status and design overview, packaging and transportation safety, and nuclear explosive operations at nuclear facilities.

How to Register:

Contact DOE Albuquerque Operations Office (505) 845-5156.

2. DOE Nuclear Explosive Safety Training (SNL NSTE 270-C)

This three-day course will help individuals in preparation to serve as members or technical advisors on Nuclear Explosive Safety Study Groups (NESSG). The course includes such topics as Nuclear Explosive Safety Program overview, terms and standards, program requirements (DOE Orders), study group procedures and requirements, assembly/disassembly operations, nuclear explosive testing, safing device principles and design, stockpile status and design overview, principles of fuzing and firing, and principles of nuclear explosive design.

How to Register:

Contact the DOE Albuquerque Operations Office (505) 845-5156.

J. Index of Courses

Course Title	Duration Hours	Source
Accident/Incident/Test Experiences (SNL NST 230)	4	Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721
An Engineering Guide to Weapons Development, Production, and Stockpile (SNL 713)	40	Sandia National Laboratories Education and Training Department (505) 844-3247
DOE Risk Assessment in Support of Nuclear Explosive Operations (SNL NSTE 408)	28	DOE Albuquerque Operations Office (505) 845-5156
Electrical Tester Safety Training (SNL NST 272)	8	Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721
Fault Tree Analysis for Component Assessment (SNL NST 416)	4	Sandia National Laboratories Education and Training Department (505) 844-4721
Fundamentals of Explosive Safety (New Mexico Institute of Mining and Technology)	24	New Mexico Institute of Mining and Technology, Energetic Materials Research and Testing Center (505) 835-5774
High Explosives (PANTEX 518.71)	2	Amarillo Area Office (806) 477-6188
High Explosives Safety - Part II Applications for Nuclear Weapons (LANL/LLNL)	16	Los Alamos National Laboratory (505) 667-6738 Lawrence Livermore National Laboratory (510) 423-1844
Historical Assessment Overview (SNL NST 210)	4	Sandia National Laboratories Education and Training Department (505) 844-4721
Lightning Phenomenology and Effects (SNL NST 450)	4	Sandia National Laboratories Education and Training Department (505) 844-4721
Nuclear Safety From Production to Retirement: Background and Principles (SNL NST 203)	4	Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721

Course Title	Duration Hours	Source
Nuclear Safety Hardware Response to Abnormal Environments and Historical Experiences (SNL NST 204)	4	Sandia National Laboratories Nuclear Safety Information Center (505) 844-4721
Nuclear Weapons Hazards (SNL NWD 906)	1	Sandia National Laboratories Military Liaison (505) 844-1172
Nuclear Weapons Orientation Course (USAF DNWS-R001)	40	United States Air Force (202) 426-1534
Nuclear Weapons Surety Assessment (SNL NST 211)	8	Sandia National Laboratories Education and Training Department (505) 844-4721
Probabilistic Safety Analysis (SNL NST 401)	16	Sandia National Laboratories Education and Training Department (505) 844-4721
Propellants and Pyrotechnics (PANTEX 518.72)	2	Amarillo Area Office (806) 477-6188
Properties of Explosive Materials (PANTEX 518.70)	4	Amarillo Area Office (806) 477-6188
Storage of Explosives (PANTEX 518.74)	2	Amarillo Area Office (806) 477-6188
Survey of Weapons Development and Technology (SNL WR 708)	40	Sandia National Laboratories Education and Training Department (505) 845-9843
Unique Signal (SNL NST 220)	4	Sandia National Laboratories Education and Training Department (505) 844-4721
Use Control and Background and PAL Systems (SNL NST 300)	8	Sandia National Laboratories Education and Training Department (505) 844-4721
DOE Nuclear Explosive Safety Training "A" (DOE/AL NTSE 270-A)	4	DOE Albuquerque Operations Office (505) 845-5156
DOE Nuclear Explosive Safety Training "C" (DOE/AL NTSE 270-C)	40	DOE Albuquerque Operations Office (505) 845-5156